IV.

PRODUCTION, USES, SOURCES, EMISSIONS, AND SMOKING TRENDS

In this chapter, we discuss tobacco production, sources of ETS emissions, adult and adolescent smoking prevalences, which was determined through the California Department of Health Services surveys during the 1990s, estimated ETS emissions in California, and smoking trends. ETS emission estimations were determined through cigarette sales in California, smoking prevalence, and emission factors for nicotine, respirable suspended particulates, and carbon monoxide. Literature published between 1992 and 2003 was used to develop this chapter.

A. PRODUCTION

Although no tobacco production occurs in California, there is a significant amount of use by the public. In 2002, over 25.4 billion cigarettes were consumed in California (CBOE, 2003). In 2002, the estimated consumption of large and small cigars in California was 247 million and 135 million, respectively (USDA, 2003b).

Tobacco is grown in 21 other states, but over 65% of United States production comes from North Carolina and Kentucky (USDA, 2001*)*. Cigarettes produced for North America are predominantly produced from various varieties of tobacco plants, including Virginia bright, burley, Maryland and Turkish. Tobacco product manufacturers employ various drying methods that yield different tobacco products ranging from light to dark; each with its unique flavor (Hoffman and Hoffman, 1997). Typically, brands employ blends of the various tobaccos.

Tobacco acreage declined about 3% during 2003 and tobacco production is at its lowest since 1908 (USDA, 2003a*)*. In 2002, over 420 billion cigarettes, 6.3 billion large and small cigars, and 9.3 million pounds of smoking tobacco (pipe and “roll your own” cigarettes) were consumed nationwide (USDA, 2003a). Tobacco can be used for cigarettes, cigars, chewing, snuff, and pipes, although cigarettes and cigars account for approximately 95% of the tobacco products produced in the United States. Cigarettes comprise 85% of tobacco products and is the main contributor to ETS (USDA, 2001).

B. USES

Staff is not aware of any industrial or commercial use of ETS. Some ETS has been used for research purposes.

C. SOURCES OF EMISSIONS

1. ETS "Point Source"

The level of ETS emissions depends in large part on the smoking public's behavior. However, at the source of ETS emissions are the combustion of individual tobacco products. The tobacco industry categorizes cigarettes and cigars according to the amount of tar and the mass of tobacco used.

Cigarette manufacturers use a number of descriptive terms in cigarette advertising, such as "light," "extra light," "medium," "mild" and "ultra light." In reality, these terms are brand descriptors (Philip Morris USA, 2003). These descriptors should not be assumed to indicate any determined amount of tar or nicotine in the cigarette.

The Federal Trade Commission (FTC) has two cigarette definitions used for advertising purposes, which is based on the amount of tar from cigarette smoke drawn in by a standardized machine and not total tar in a cigarette. The first category is "low tar", which describes machine-measured tar yields in cigarettes having a tar content of 7 - 15 milligrams (mg). The second category is "ultra low tar," which indicates the machine-measured tar amount of a cigarette to be 6 mg or less (FTC, 1997). However, these descriptors do not correspond to the actual tar and nicotine levels a smoker would inhale. Studies have revealed that light and regular cigarettes can deliver the same tar and nicotine levels (Burns and Benowitz, 2001). In 1998, nearly 82% of all cigarettes sold had a tar value of 15 mg or less (FTC, 2000).

To evaluate the effects of cigarettes on mainstream emissions, Djordjevic *et al*. (2000), compared carbon monoxide (CO) emissions from two cigarettes advertised as having either a nicotine content of 0.6 - 0.8 mg, or 0.9 - 1.2 mg per cigarette. Table IV-1 compares the yields of nicotine, tar and carbon monoxide for cigarettes tested under the FTC standard machine smoking procedure, compared to the emissions generated by an

Table IV-1

Comparison of FTC and Actual Cigarette CO Emissions

	FTC Machine		*Actual Smoker*	
	0.6-0.8 mg Nicotine	0.9-1.2 mg Nicotine	0.6-0.8 mg Nicotine	0.9-1.2 mg Nicotine
Nicotine (mg/cig.)	0.7	1.11	1.74	2.39
Tar (mg/cig.) a/	8.5	15.4	22.3	29.0
CO (mg/cig.)	**9.7**	**14.6**	**17.3**	**22.5**
Puff:				
Volume (ml)	35.0	35.0	48.6	44.1
Interval (sec)	58.0	58.0	21.3	18.5
Duration (sec)	2.0	2.0	1.5	1.5

Source: Djordjevic *et al.*, 2000

a/ Total tar particulate matter minus water and nicotine

actual smoker. The results indicated that, for the 0.6 - 0.8 mg cigarettes, smokers inhaled 1.74 mg of nicotine while the FTC machine only measured 0.7 mg of nicotine per cigarette. Similarly, smokers inhaled 22.3 mg of tar while the FTC machine measured 8.5 mg of tar. The National Cancer Institute Monograph 13 concluded that measurements of tar and nicotine yields using the FTC method do not offer smokers meaningful information on the amount of tar and nicotine that they will receive from smoking low tar and low nicotine cigarettes (Kozlowski *et al.*, 2001). As shown in Table IV-1, actual smoker mainstream smoke concentrations are greater than those levels generated by the FTC machine methodology.

Sidestream smoke is primarily related to the weight of the tobacco and paper consumed during smoldering periods (USEPA, 1992). A number of studies indicate that sidestream smoke emissions show little variability among different types of cigarettes, such as full flavor or low tar (USEPA, 1992; Jenkins *et al*., 2000; Leaderer and Hammond, 1991). Consequently, studies do not show sizeable decreases in total ETS emissions due to the marketing of low tar and low nicotine cigarettes. When comparing tar and nicotine content in cigarettes sold in the United States, the measured yields tend to be 10 - 20 times more tar than nicotine (FTC, 2000).

The FTC separates cigars into three weight categories based on the mass of 1,000 cigars. The FTC designation of “little” cigars are those that weigh less than three pounds per 1,000 cigars, while “medium” cigars weigh three to ten pounds per 1,000 cigars. FTC’s designation for “large” cigars includes the weight category of ten or more pounds per 1,000 cigars.

In 1997, the domestic market share among small, medium and large cigars was 26.6%, 35.3%, and 38.2%, respectively (FTC, 1999). Although cigar consumption is regularly reported as large cigars, consumption for small cigars can be estimated by domestic invoices (USDA, 2003b). In 1997, over 5.1 billion cigars were consumed nationwide, whereas, in 2002, cigar consumption increased by over 20% to 6.3 billion cigars (USDA, 2003b).

In a study by Repace (2001), large cigars were found to produce greater total emissions compared to cigarettes and contained most of the same toxic and carcinogenic constituents found in cigarette smoke. Emissions from one cigar have been shown to exceed those of three cigarettes, which are simultaneously consumed, and can contain up to 70 times as much nicotine as individual cigarettes (Henningfield *et al*., 1996). However, because cigars comprise such a small percentage of tobacco products consumed, cigarette consumption accounts by far for most of the ETS emissions.

2. Smoking Prevalence in California

While consumption of individual tobacco products is the origin of ETS, it is the smoking public that dictates the nature and quantity of ETS emissions the public is exposed to in the environment. To understand the segments of the population, which contribute most to ETS emissions, staff evaluated data on smoking prevalence. Simply put, prevalence measures a practice regarding whether it is widespread or universally accepted. Researchers have measured data on smoking prevalence, attitudes, behaviors, and exposure for years through the use of detailed questionnaire surveys. Data is compiled for various subpopulations according to age, ethnicity, educational background, and several other categories.

The California Department of Health Services (CDHS) conducts surveys regarding smoking and tobacco use through the implementation of Proposition 99, the Tobacco Tax and Health Protection Act of 1988, and other California Assembly Bills which reauthorized provisions of Proposition 99. The CDHS conducted surveys in 1990, 1992, 1993, 1996, 1999, 2001, and 2002 (CDHS, 2003a, b). For these surveys, the CDHS contracted with the Cancer Control and Prevention Division at the University of California, San Diego and WestEd, Inc. The surveys are used as the basis for tracking the progress of the smoking cessation evaluation effort. To ensure the most accurate smoking prevalence estimates, survey methodologies occasionally alter questions or approaches over time.

The CDHS gathered important information about smoking behavior through the California Tobacco Surveys (CTS). These surveys are designed to obtain representative statewide data on the percent of the smoking population, attitudes towards smoking, perceptions regarding media coverage and use of tobacco products other than cigarettes. The CTS are random-participation telephone surveys targeting various groups, including adolescents (12 - 17 years) and adults (18+ years) (Gilpin *et al.*, 2001). Over 91,000 households were contacted among the past six CTS studies.

Another survey funded by CDHS is the California Student Tobacco Survey (CSTS). This survey is a large-scale, in-school student survey of tobacco use which collects data from both middle (grades 6 - 8) and high school (grades 9 - 12) students. This adolescent survey is considered a more accurate survey since students respond directly to solicitors and are not inhibited by the presence of their parents. The first CSTS data were weighted relative to the 2001 population of California in-school youth, by gender, grade level, and race/ethnicity. However, for the first CSTS, only high school data was available due to an insufficient sample size for middle school students.

As shown in Figure IV-1, during the past decade smoking prevalence among adults and adolescents has gradually decreased (Gilpin *et al.*, 2001). The adult smoking prevalence shown in Figure IV-1 is based on total daily smokers (smokers who now smoke everyday) and occasional smokers (smokers who now smoke some days). Beginning with the 1996 CTS, a new survey question was added to update adult smoking prevalence by capturing more “occasional” smokers. The 1996 CTS used both the “old” and “new” smoking question, which resulted in two different estimates of adult

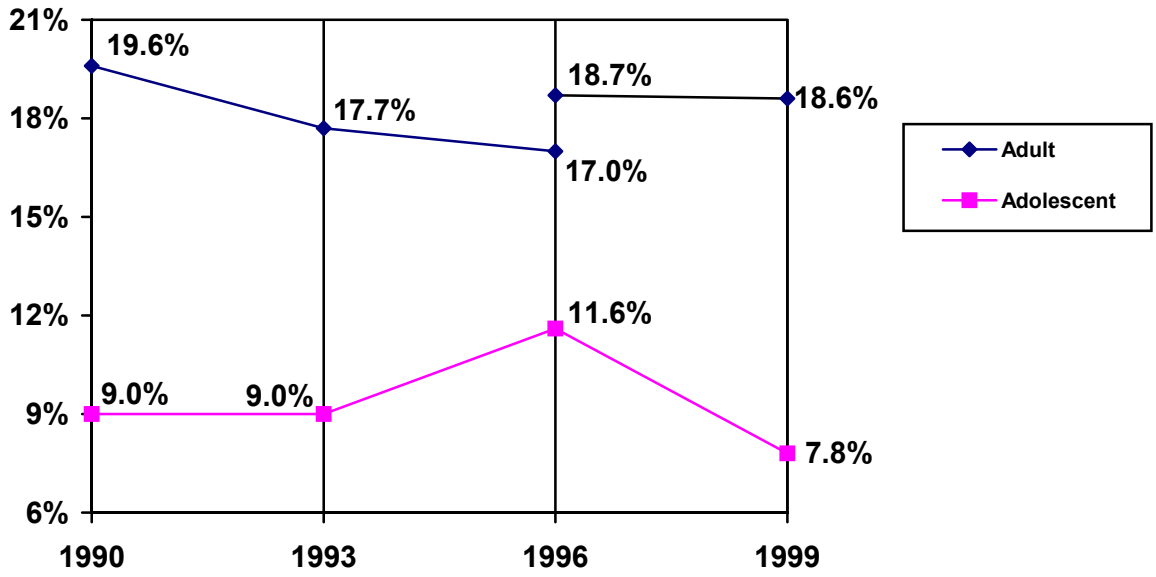
smoking prevalence. Adolescent smoking prevalence is based on criteria of any smoking within the last 30 days.

Although adolescent prevalence in California increased between 1993 and 1996, the overall smoking prevalence has decreased since 1990. In addition to overall reductions in daily adult smoker prevalence, the number of cigarettes that adults consume also appears to be decreasing as well. Heavy daily smokers (15 or more cigarettes per day) have declined considerably, while converting to occasional smoking (less than 15 cigarettes per day) (Gilpin *et al.*, 2001).

Smoking patterns among current California adult smokers have changed over time. Since the passage of Proposition 99 in 1988, the annual adult per capita cigarette consumption in California has declined by over 60%, from 126.6 packs in 1988 to 50.6 packs in 2001 (CDHS, 2003b). Adult smoking prevalence in California has decreased at a faster rate relative to the rest of the nation. However, the 18 - 24 age group has shown signs of a much smaller overall decrease. Adult male and females have remained fairly consistent in smoking prevalence rate. Non-Hispanic whites (Caucasian) show the greatest smoking prevalence, while Asians and Hispanics have the lowest smoking prevalence. African-Americans have shown the greatest decline of smoking prevalence since 1990.

Figure IV-1

[1]Adult and [2]Adolescent Smoking Prevalence in California (1990-1999)



[1] Smoking prevalence based on daily and occasional smokers
[2] Smoking prevalence based on any smoking within the last 30 days
Source: Gilpin *et al.*, 2001. The California Tobacco Control Program: A Decade of Progress, Results from the California Tobacco Survey, 1990-1999.

Table IV-2 shows the overall smoking prevalence from the current adult and adolescent surveys. In contrast to adult females, males have a higher smoking prevalence. In particular, young males between 18 - 24 years of age show no indication of reduced smoking prevalence.

From the 2001 adolescent CSTS results, adolescents that are in 9th grade showed a significantly smaller smoking prevalence than the students in 12th grade. Differences in gender smoking prevalence vary more so for adults as compared to adolescents. Adult and adolescent non-Hispanic whites are among the higher prevalence throughout the major ethnic demographic groups within California based on the new surveys.

Table IV-2

Current [1]Adult and [2]Adolescent Prevalence (%)

	Adult (%)	Adolescent (%)
Overall	16.2	16.0
Gender		
Male	19.5	16.2
Female	13.0	15.7
Age		
Grade 9		10.4
Grade 10		14.8
Grade 11		17.6
Grade 12		22.9
18-24	18.0	
25-44	18.1	
45-64	16.4	
65+	7.6	
Race/Ethnicity		
African-American	19.0	8.2
Asian/PI	12.1	13.6
Hispanic	13.4	14.0
Non Hispanic White	17.3	19.9

Source: CDHS, 2003b. The California Tobacco Control Program
[1] Adult results from the 2002 California Tobacco Survey,
[2] Adolescent results from the 2001 California Student Tobacco Survey

D. ETS EMISSIONS

As mentioned in Chapter III, ETS is a mixture containing thousands of different compounds. To estimate the total amount of ETS emissions within the State, one would have to add the amounts of all individual compounds emitted from tobacco products.

However, this is not practical since it requires the development of analytical methods to detect and measure several ETS compounds, at a very significant cost.

Therefore, to simplify the emission estimation, staff characterized ETS emissions as nicotine, respirable suspended particulate (RSP), and carbon monoxide (CO). In general, the estimate of cigarette ETS emissions was based on the following equation:

Emissions (tons/yr)= EF x N x 90% x CF;

where: EF = Average cigarette emission factor (mg/cig)
N = Number of cigarettes per year (cig/yr)
CF = Units conversion factor (tons/mg)

For purposes of this estimate, we assumed a uniform consumption rate among the population. A 90 percent adjustment factor was also applied to account for the remaining "butt" which smokers typically discard (Hildemann *et al.,* 1991). Depending on the factor used for N, number of cigarettes per year, emissions can be estimated for different geographic regions and demographic groups.

Apportioning ETS emissions as either outdoor or indoor emissions is difficult to determine due to limited information. However, other associated data can be viewed to give some insights. Outdoor ETS emissions would include direct emissions from outdoor smoking, plus ETS emissions generated indoors which eventually ventilate outside. Given the enactment of Assembly Bill 13 (AB 13) in 1998, all workplaces (including bars and restaurants) are now smoke-free in California. There are likely some workplaces that don't comply with AB 13, but we expect that a vast majority of workplaces are smoke-free. In addition, smoking behavior has changed as well. Based on the 2002 California Adult Tobacco Survey (CATS), over 80% of all California homes with children are now smoke-free. Of California smokers, 50% have reported smoking bans in their homes. Therefore, with no indoor smoking in workplaces, other public venues, and half of California smoker residences having indoor smoking bans, we assume that most physical smoking occurs outdoors. For ETS generated indoors, building ventilation studies show that 50 – 80% of ETS (including ETS constituents) is exchanged with outdoor air over a given time period (Rogge *et al.*, 1994). From all of the available information, the ARB staff estimates that at least 80% of total ETS emissions (including those directly emitted outdoors and emissions ventilated from indoors) are emitted to the outdoor environment. Appendix B presents the calculation methodology for estimating outdoor ETS emissions.

1. ETS Emissions by Region

In the previous section regarding sources of ETS, we identified which California demographic groups contribute to ETS emissions. However, to estimate the quantity of ETS emissions, a straightforward calculation was employed that utilizes the most recent information on demographics, emission rates and cigarette consumption. For a detailed description of the emissions estimation methodology that we used, refer to Appendix B of this report.

To estimate ETS emissions, we used specific data sets including: the 2002 CDHS survey (adult prevalence), the 2001 CSTS (adolescent survey), the 2002 U.S. Census Bureau (population) and the Board of Equalization (CBOE) 2001-02 cigarette distributions in California (i.e., cigarettes consumed). We also reviewed several studies to determine representative emission factors.

Table IV-3 shows staff's estimated total statewide ETS emissions for nicotine, RSP, and CO from cigarettes and cigars. These emissions were derived from smoker population and smoking prevalence data within the different regions throughout the state. Smoking behavior was assumed to be uniform among the various demographic groups.

Estimates for CO and RSP indicate very low levels relative to total emissions. ETS emissions of CO represent less than one percent of total statewide emissions. Our RSP estimate is based on studies predominantly measuring ETS particulate less than PM_4. On this basis, ETS derived RSP contributes less than one percent to total statewide PM_{10} emissions. By comparison, diesel exhaust particulate also contributes less than one percent of total statewide PM_{10} emissions. Currently, ARB does not have an emissions inventory for nicotine. However, the estimated ETS nicotine emissions are expected to represent most of the statewide inventory, in addition to two pounds of reported pesticide use by the Department of Pesticide Regulation. While emissions may seem to be low, high exposures can result due to the generally close proximity of non-smokers to smokers (see Chapter V).

Table IV-3

2002 California Statewide ETS Emissions (Tons/Year)

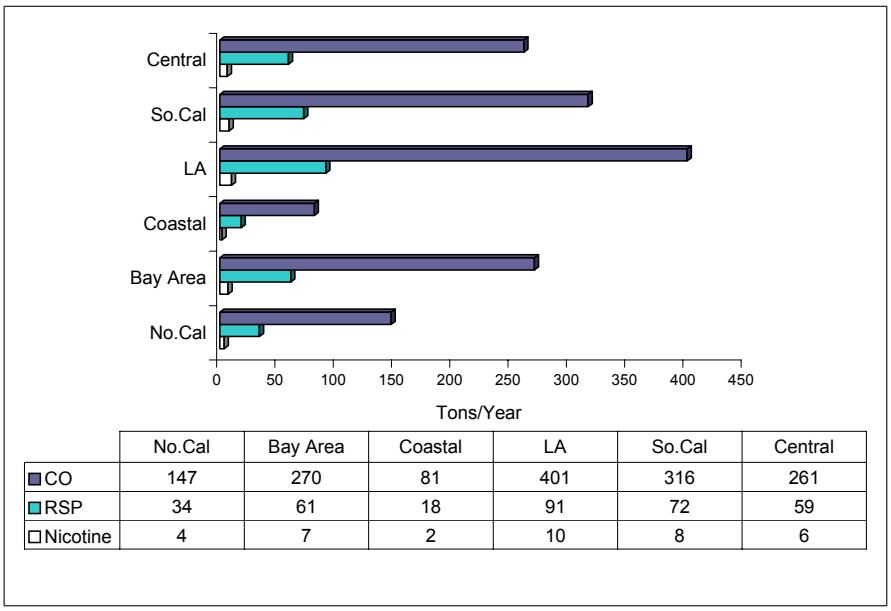
	Cigarettes	Cigars	[a]Total
Nicotine	36	4	40
RSP	335	30	365
CO	1475	432	1907

[a] Staff estimates 80-90% of total emissions reside outdoors

Figure IV-2 shows staff's calculated ETS emissions from cigarettes for various regions within the State. Appendix B (Attachment A) of this report presents the calculation methodology and estimated emissions by region within California. As expected, the highest ETS emissions correspond to areas of the highest population and population density.

Figure IV-2

Regional ETS Emissions From Cigarettes



	No.Cal	Bay Area	Coastal	LA	So.Cal	Central
CO	147	270	81	401	316	261
RSP	34	61	18	91	72	59
Nicotine	4	7	2	10	8	6

2. Comparing California and Total U.S. ETS Emissions

For the past 20 years, California cigarette consumption and ETS emissions have continued to decline. Whereas, the total U.S. cigarette consumption and ETS emissions have fluctuated. In 2002, California accounted for over 6% of the total cigarette emissions in the U.S. The quantity of ETS emissions was mainly determined using the most recent emission rate data and 2002 U.S. cigarette consumption numbers (Orzechowski and Walker, 2002). Table IV-4 shows staff's estimated total statewide and U.S. ETS emissions for nicotine, RSP, and CO from cigarettes and cigars.

Table IV-4

California vs. U.S. ETS Emissions

	Nicotine Emissions (tons)		RSP Emissions (tons)		CO Emissions (tons)	
Fiscal Year	CA	Total U.S.	CA	Total U.S.	CA	Total U.S.
2001-02	40	647	365	5,860	1,907	30,200

In 2002, California had a low smoking adult prevalence (16.2%) rate compared to the overall U.S. prevalence (23.0%). In fact, the U.S. per capita cigarette consumption (74.6 packs per fiscal year) is over twice as high as California's (35.8 packs per fiscal year). This explains why California only contributed a small percentage (≈ 6.0%) of the total ETS emissions.

3. ETS Emissions by Age

In addition to regional emission estimates shown in Appendix B, staff also estimated ETS emissions amongst two age groups: adults and adolescents. These two groups comprise the majority of all California smokers. See Appendix B for a complete discussion for the methodology used by staff.

To characterize reported emissions, Table IV-5 presents the 2002 California adult and adolescent population and cigarettes consumption data.

Table IV-5

2002 California Adult and Adolescent Cigarette Consumption (millions)

	Adult (18+ years of age)	Adolescent (12 - 17 years of age)
Population	25.7	2.8
Smoker Population	4.2	0.4
Cigarettes Consumed	22,994	2,426

Population, smoking prevalence among daily and occasional smokers, and average emission factors were all considered in determining adult and adolescent emissions of nicotine, RSP, and CO, see Table IV-6.

Table IV-6

Adult vs. Adolescent Cigarette ETS Emissions (Tons/Year)

	Adult (18+)	Adolescent (12 - 17)	[a]Total
Nicotine	32.9	3.5	36.4
RSP	303	32	335
CO	1,335	141	1,476

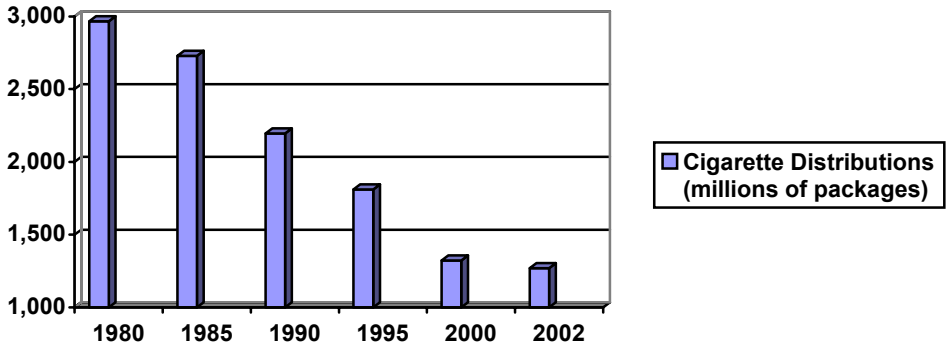
[a] Staff estimates 80-90% of total emissions reside outdoors

E. ETS EMISSIONS PROJECTION

The future trend of ETS emissions largely depends on smoking prevalence in California. Figure IV-1 shows how the adult and adolescent smoking prevalence has declined over the past several years. Likewise, Figure IV-3 indicates that since 1980 cigarette distributions (and per capita consumption) in California have decreased as well.

Figure IV-3

Cigarette Distributions in California



Source: CBOE (2003). *2001-2002 Annual Report, Table 30B – Cigarette Distributions and Per Capita Consumption, 1959-60 to 2001-02*

Current anti-smoking mandates within the California Health and Safety Code (Section 104350-104545) will ensure that California's smoking prevalence among adults and adolescents continues to decrease. In 1989, the California Legislature enacted Assembly Bill (AB) 75, which set an ambitious goal to reduce tobacco use in California by 75% by 1999. While state agencies did not meet the 75% reduction in tobacco consumption by 1999, the California Legislature found that California's anti-smoking campaign, which is overseen by the Tobacco Education and Research Oversight Committee (TEROC), was a success. Per capita cigarette consumption declined by over 50% and adult smoking prevalence was reduced by more than 25% between 1989 and 1999 (TEROC, 2000).

The TEROC was created by Health and Safety Code Section 104365 and is composed of 13 appointed members of varying backgrounds such as public health, research and education. The committee's purview includes oversight responsibilities and advising the Department of Health Services, the University of California, and the State Department of Education on policy development and evaluation of tobacco education. Under Health and Safety Code Section 104370(f), the TEROC is also mandated to develop a "master plan" to attain future reductions of smoking prevalence in California.

The TEROC policy is to continue focusing on programs that prove effective in reducing smoking prevalence and consumption. According to their January 2003 master plan, TEROC's intermediate goal is to reduce total (i.e., daily and occasional smokers) adult smoking prevalence in California to 13% and total adolescent smoking prevalence to 4% by 2005. The long-term goal is to reduce total adult smoking prevalence in California to 10% and total adolescent smoking prevalence to 2% by 2007 (TEROC, 2003).

Therefore, if TEROC's plan to achieve further reductions proves to be successful, then ETS emissions will gradually trend downwards. A quantifiable assessment is not possible, since the ultimate indicator of ETS emissions relates to the total number of cigarettes consumed (i.e., cigarette distributions) by California's smoking public.

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